

GUJARAT TECHNOLOGICAL UNIVERSITY**M. E. - SEMESTER – II • EXAMINATION – SUMMER • 2014****Subject code: 1723003****Date: 20-06-2014****Subject Name: Advance Equipment Design****Time: 02:30 pm - 05:00 pm****Total Marks: 70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.

- Q.1** Filtration is carried out in plate & frame filter press with 20 frames 0.3 m and 50 mm thick and rate of filtration is maintain constant for first 300 sec. During this period the pressure is raised to 350 kN/m^2 and one-quarter of total filtrate is obtained per cycle. At the end of constant rate period, filtration is continued at a constant pressure of 350 kN/m^2 for a further 1800 sec, after which the frames are full. The total volume of filtrate per cycle is 0.7 m^3 and dismantling & refitting of the press takes 500sec. **14**
- It is decided to use rotary drum filter, 1.5 m long and 2.2 m in diameter in place of the filter press. Assuming that the resistance of the cloth is the same in the two plants and that the filter cake is incompressible, calculate the speed of the rotation of the drum which will result in the same overall rate of filtration was as was obtained with the filter press. The filtration in the rotary filter is carried out at constant pressure difference of 70 kN/m^2 and filter operates with 25% of the drum submerged in the slurry at any instant.
- Q.2 (a)** In a steam super heater having staggered layout of tubes ($S_1=2d_0, S_2=2.5 d_0$), the hot flue gas enters at 1150°C and leaves at 850°C , the outer surface temperature of the tubes may be assumed to be constant and equal to 600°C . Determine the coefficient of heat transfer by radiation from the flue gas to the surfaces of the superheated tubes. Emissivity of the tube surface is 0.85. **07**
- Given data:
Tube OD=55 mm
Flue gas pressure=1 atm
Flue gas composition: $\text{CO}_2=13\%$, $\text{H}_2\text{O}=11\%$ and N_2 rest.
- (b)** Discuss the construction and working of filter press. **07**
- OR**
- (b)** Explain different types of moisture along-with the graph for drying. **07**
- Q.3 (a)** Sodium sulphate crystals are to be produced from an aqueous solution of sodium sulphate available at 104°C . Total weight of solution is 8600 kg and it contains 29.6% by weight of anhydrous sodium sulphate. During cooling, 4.5% of the initial water is lost by evaporation. The mother liquor contains 18.3% by weight of anhydrous sodium sulphate. Estimate the yield of crystals and the quantity of mother liquor to be recycled from the crystallizer. **07**
- Data:
Molecular weight of anhydrous sodium sulphate crystals = 142
Molecular weight of hydrated sodium sulphate = 322
- (b)** Calculate the size of cyclone needed to separate the dry material from air leaving the spray dryer according to the following data: **07**
- Data:
Smallest particle diameter=80 μm
Flow-rate of air=2000kg/hr

Local resistance coefficient (dimensionless resistance coefficient of a cyclone), $\epsilon = 160$
 Temperature = 100°C
 Give a neat sketch of designed equipment.

OR

- Q.3** Design a horizontal extractor to treat 1000 kg of seeds/hr containing 30% oil, to recover 95% oil. Solvent lost with the seeds is 10% (of the seeds coming out). Solvent charged is 1000 kg/hr. Find the number of stages. If the contact time required is 6 min and draining time is 6 min, find out the length of the belt to be provided considering loading and unloading length. Thickness of the seed layer over the belt is 50 mm and Effective breadth of the belt is 1m. Find out the linear speed of the belt. **14**

X:	0.02	0.025	0.055	0.095	0.135	0.19	0.2075
Y:	0.02	0.07	0.09	0.125	0.173	0.235	0.27

N:	4.5	2.35	1.97	1.6	1.325	1.05	0.95
Y:	0.02	0.07	0.09	0.125	0.173	0.235	0.27

Where, $N = \text{Wt of insoluble} / (\text{Wt of oil} + \text{Wt of hexane})$
 $X = \text{Wt. of oil} / (\text{Wt. of oil} + \text{Wt. of hexane})$ in raffinate phase
 $Y = \text{Wt. of oil} / (\text{Wt. of oil} + \text{Wt. of hexane})$ in extract phase

- Q.4** A rotary dryer using countercurrent flow is to be used to dry 12000 Kg/hr of wet salt containing 5 % water (wet basis) to 0.1% water (wet basis). Heated air at 147°C with 50°C wet bulb temperature is available. The specific heat of salt is $0.21 \text{ Kcal/Kg}^{\circ}\text{C}$. The outlet temperature of air and salt are 72°C and 93°C respectively. **14**
 Assuming suitable mass velocity of gas ($= 5000 \text{ kg/hr m}^2$)
 Calculate the length and diameter of dryer required.

$\alpha_{(\text{water})}$ at $50^{\circ}\text{C} = 569 \text{ Kcal/Kg}$
 Specific heat of solids (C_{ps}) = $0.21 \text{ Kcal/kg }^{\circ}\text{C}$
 Specific heat of water vapour (C_{pv}) = $0.45 \text{ Kcal/kg }^{\circ}\text{C}$
 Specific heat of liquid (C_{pL}) = $1 \text{ Kcal/kg }^{\circ}\text{C}$
 Specific heat of dry air = $0.2566 \text{ Kcal/kg }^{\circ}\text{C}$
 Temperature of entering solid = 30°C

OR

- Q.4** Caustic soda is being made by treatment of slaked lime Ca(OH)_2 , with a solution of sodium carbonate. The resulting slurry consists of particles of calcium carbonate (CaCO_3), suspended in a 10% solution of sodium hydroxide (NaOH), 0.125 kg suspended solid/kg solution. This is settled, the clear sodium hydroxide solution withdrawn and replaced by an equal weight of water and the mixture thoroughly agitated. After repetition of this procedure what fraction of the original NaOH in the slurry remains unrecovered and therefore lost in the sludge? The settling characteristic of the slurry, determined under conditions representing the practice to be followed in the process. **14**

x = Weight fraction of	N	y*
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NaOH in clear solution		
0.0900	0.495	0.0971
0.0700	0.525	0.0762
0.0473	0.568	0.0608
0.0330	0.600	0.0452
0.0208	0.620	0.0295
0.01187	0.650	0.0204
0.00710	0.659	0.01435
0.00450	0.666	0.01015

Q.5 (a) Show with diagram the distribution of the radiant rate on the tube circumference for the single row of tubes in a furnace. **07**

(b) A solution of 500 kg of sodium sulphate (Na_2SO_4) in 2500 kg of water is cooled from 333 to 283 K in an agitated mild steel vessel of mass 750 kg, the specific heat of steel being 0.5 KJ/kgK at 283K. The stable crystalline phase is $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$ and at 291 K the heat of solution is -78.5 MJ/kmol. The mean heat capacity of the solution is 3.6 KJ/kgK. If during cooling 2% by mass of the water is lost by evaporation, estimate the yield of crystals formed and the heat to be removed. The solubility of the anhydrous salt at 283k is 8.9 KJ/100kg water. **07**

OR

Q.5 (a) Explain construction and working of Forced-Circulation Evaporator Crystallizer with the help of neat sketch. **07**

(b) Explain construction and working of Box-Type Furnace with the help of neat sketch. **07**

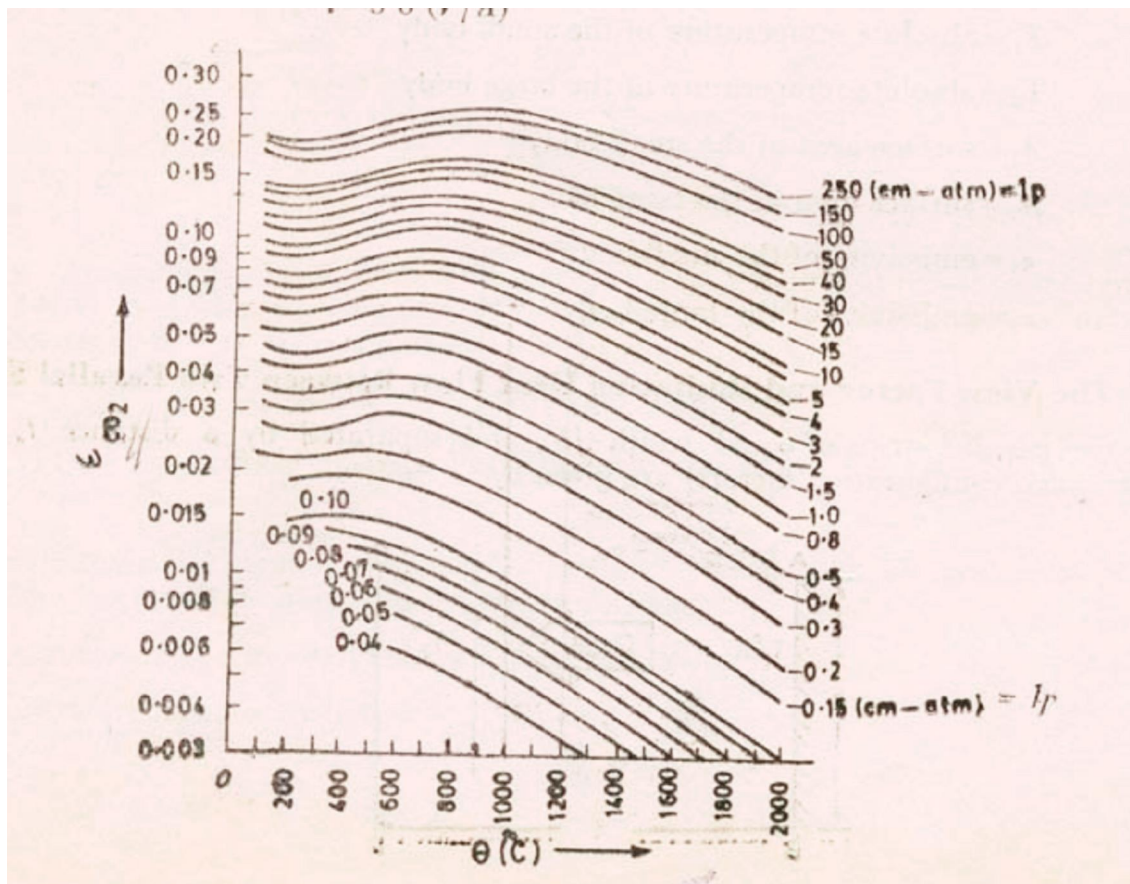


Fig. 1 Emissivity of Carbon-dioxide

Fig. 2 Emissivity of Water Vapour

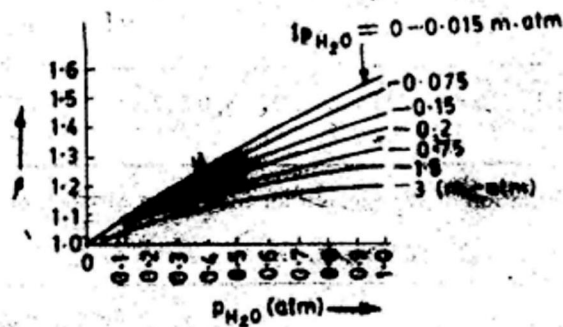
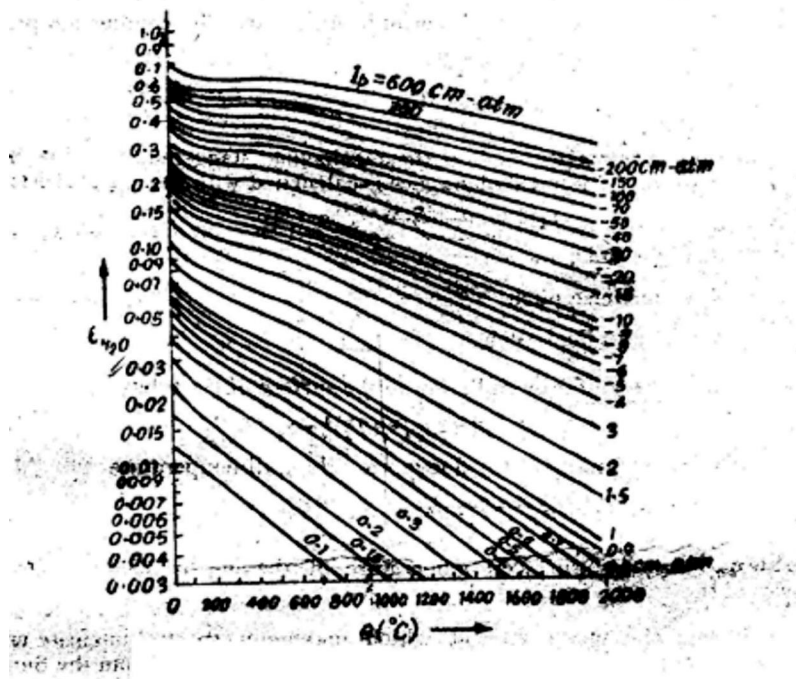


Fig.3 $C\beta$ vs p_{H_2O}
